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NASA TECH BRIEF

Soluble High Molecular Weight Polymide Resins

Characterization Test	Test Results
1. Inherent viscosity* (in 0.5% dimethyl formamide)	0.4 deciliters per gram
2. Molecular weight	>20,000
3. Thermal stability (thermal gravimetric analysis)	>300°C
4. Isothermal weight loss [in air at 600°F (170 hours)]	8%
5. Tensile strength	>10,000 psi
6. Elongation	10%
7. Initial modulus (determined on 1-mil-thick film samples by triplicate Instron breaks)	300,000 psi
8. Solubility	20% polymer in: Dimethyl formamide; Dimethyl sulfoxide; Hexamethyl phosphoramide; Chloroform
9. Film appearance (by sight)	Clear
10. Film appearance (by touch)	Tough, creasable

*Capability of polymer to increase viscosity of solvent -- natural logarithm of relative viscosity per concentration.

Continuing research on new polyimide resins is being directed toward improving processing capabilities as well as physical and chemical properties. Recent work has produced a new class of high molecular weight polyimide resins which have greater than 20% (by weight) solubility in polar organic solvents. Thus, these polyimides permit fabrication into films, fibers, coatings, reinforced composite, and adhesive product forms. Other outstanding characteristics include good thermo-oxidative stability (up to 600°F) and excellent

(continued overleaf)

mechanical properties, such as toughness, flexibility, and high modulus. Having relatively straightforward preparation and fabrication characteristics, and stable shelf life in solid or varnish form, these soluble high molecular weight polyimide resins could be used in many industrial applications.

Because of solubility limitations of currently available fully cured polyimide resins, they are usually marketed in an amic-acid precursor form. Processing is difficult, however, because the precursor is thermally and hydrolytically unstable, and for condensation cure reactions, volatile material is released when chemically advancing the precursor to the polyimide form.

The new polyimides are prepared from a new dianhydride monomer, and aromatic and aliphatic diamines and diisocyanates. One new polyimide is prepared by reacting appropriate quantities of the ingredients in common organic solvents, such as dimethyl formamide. The fully imidized high molecular weight resins can be separated for ease in storage. At a later date they can be redissolved in common organic polar solvents to greater than 20% w/w solubility, to form varnishes for use in preparing cast polyimide films, fibers, coatings or reinforced composite products.

The characterization properties for one typical soluble polyimide resin composition are listed in the Table.

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Administration Act [42 U.S.C. 2457 (f)] to TRW Systems Group, One Space Park, Redondo Beach, California 90278. (Attn: Mr. Ernest R. Boller)

Source: H.R. Lubowitz and R.J. Jones of TRW Systems Group under contract to Lewis Research enter (LEW-11056)